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IMPROVED TRANSMITTANCE MEASUREMENTS IN A MAGNESIUM OXIDE COATED INTEGRATING SPHERE

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16. Abstract

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SUMMARY

A simple and convenient technique which was found to be useful for extending the transmittance measurement capability at low (near ultraviolet) wavelengths for a conventional magnesium oxide coated integrating sphere system is described. The technique is to place a sodium salicylate coated disk in the center of the integrating sphere. With the coated disk, the detector output is increased; accurate transmittance measurements can be made to wavelengths of 0.25 micrometer with a tungsten lamp and to 0.22 micrometer with a deuterium lamp, whereas previous transmittance measurements had been limited to wavelengths of 0.32 and 0.26 micrometer, respectively.

INTRODUCTION

Recently a study was undertaken to determine the effects of surface contamination on the transmittances of various optical materials. In order to obtain a preliminary evaluation of the effects of contaminants on fused quartz substrates, an existing prism monochromator with a magnesium oxide (MgO) coated integrating sphere attachment was used to make spectral transmittance measurements. The initial measurements indicated that the primary effect of the contaminants on spectral transmittance generally occurred at wavelengths less than 0.32 micrometer, and the effect increased as the wavelength decreased. However, the accuracy of the measurements that could be made at the short wavelengths with the existing system (ref. 1) was limited by a combination of low signal level, system instability, and electronic noise. In order to study the effects of contamination, it was desirable to improve the transmittance measurement capability of the existing system at the short wavelengths. A simple and convenient technique is described which has been found to be useful for extending the near ultraviolet wavelength

capability of the existing spectrometer system without disturbing the visible and near infrared transmittance measurement capability.

PROCEDURE

The instabilities and noise in the system which were limiting the transmittance measurements at the short wavelengths were found to be independent of the signal level. Thus, the accuracy of the measurements could be improved if the detector output could be increased. To achieve this increase in the signal level for wavelengths less than 0.35 micrometer, a 25-millimeter-diameter sodium salicylate coated disk was introduced into the center of the integrating sphere with the coating facing the incident radiation. Sodium salicylate was selected because it is widely used for ultraviolet radiation measurements. Ultraviolet radiation (wavelengths less than 0.35μm) causes the sodium salicylate to fluoresce in a band centered around 0.435 micrometer. With the coated disk mounted in the center of the sphere, the short-wavelength radiation strikes the sodium salicylate rather than the MgO coating. It is the 0.435-micrometer radiation which then is reflected from the sphere wall and measured by the detector. Since the sensitivity of the photomultiplier detector (1P28) and the reflectance of the MgO are higher at 0.435 micrometer than at the shorter wavelengths, an increase in the measured signal could be expected.

The sodium salicylate coating was sprayed on a fused silica substrate by an air-brush method similar to that described in reference 2. The applied coating was 6 milligrams per square centimeter thick, which is in the range of thicknesses reported by Kristianpoller and Knapp (ref. 3) to give optimum efficiency.

RESULTS

Figure 1 shows the detector signal obtained with and without the sodium salicylate by using a 30-watt deuterium lamp as the source. Also shown in the figure is the gain (ratio of the signal obtained with the sodium salicylate to that obtained without), which increases from 1 at about 0.33 micrometer to almost 6 at 0.215 micrometer. With the sodium salicylate coated disk and the deuterium lamp, transmittances could be accurately measured down to 0.22 micrometer. Without the sodium salicylate disk, accurate transmittance measurements with the deuterium source were limited to wavelengths greater than 0.25 micrometer.

The sodium salicylate coated disk was also used with a 1-kilowatt tungsten filament lamp which is generally used for transmittance measurements for wavelengths from 0.32 to 2.2 micrometers. For this source, the gain was the same as that obtained for

the deuterium lamp except that gain measurements could be made only to 0.26 micrometer because of the low ultraviolet output of the 1-kilowatt lamp. With the sodium salicylate coated disk, accurate transmittance measurements with the 1-kilowatt source could be made to 0.26 micrometer as compared to the previous lower wavelength limit of 0.32 micrometer without the sodium salicylate disk.

With the sodium salicylate coated disk in the center of the sphere, absolute transmittance measurements are limited to samples which do not scatter the transmitted radiation. This limitation is due to the requirement that all of the transmitted radiation must be incident on the coated disk. However, the center-mounted sodium salicylate disk can be used with a scattering sample if only qualitative changes in transmittance are required.

CONCLUDING REMARKS

Even though there are other techniques and systems which can be used for ultraviolet measurements, the use of the center-mounted sodium salicylate disk affords a convenient and simple means of improving the transmittance measuring capability of a conventional MgO coated integrating sphere for wavelengths to 0.22 micrometer. The disk can be quickly and conveniently introduced and removed from the system. This is of particular advantage for our system when the 1-kilowatt tungsten lamp is being used for long-wavelength (0.3- to 2.5-μm) measurements. When the deuterium lamp is used as the source, the signal gain can be as high as 6 at the short wavelengths. This is a significant improvement for the very low signal levels generally encountered.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, July 21, 1971,
124-09.

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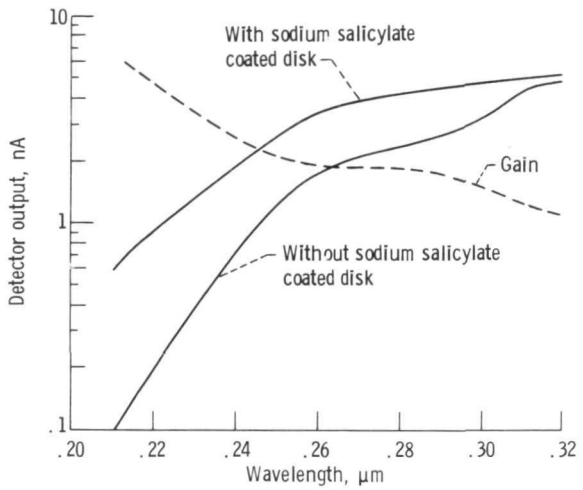

Figure 1. - Detector output with and without sodium salicylate coated disk mounted in magnesium oxide coated integrating sphere.

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